What is claimed is:

Sub A1

1. A projection optical system which forms an image on a first plane on a second plane, comprising:

a first diffractive optical element arranged in an optical path between said first plane and said second plane;

a second diffractive optical element arranged in the optical path on the side of said second plane from said first diffractive optical element; and

an optical system having a negative power, arranged in the optical path between said first diffractive optical element and said second diffractive optical element.

2. A projection optical system according to claim 1, further comprising:

a front optical system arranged between said first plane and said first diffractive optical element; and

a rear optical system arranged between said second diffractive optical element and said second plane;

and said front optical system converts an axial luminous flux on said first plane to a substantially parallel luminous flux, and guides said parallel luminous flux to said first diffractive optical element; and

said optical system having a negative power converts an axial luminous flux on said first plane via said first diffractive optical element again to a substantially parallel luminous flux, and guides said parallel luminous flux to said second diffractive optical element.

Sub A2

3. A projection optical system which forms an image on a first plane on a second plane, comprising:

a diffractive optical element arranged in an optical path between said first plane and said second plane; and

an optical system arranged in the optical path between said first plane and said diffractive optical element;

wherein when a numerical aperture on the side of said second plane of said projection optical system is designated as NA, an imaging magnification of said optical systems from said first plane to immediately before said diffractive optical element is designated as β, the focal length of said diffractive optical element with respect to a predetermined wavelength is designated as f, and the distance from said first plane to said second plane is designated as L, said projection optical system satisfies the following conditions:

$1/|NA \cdot \beta| < 0.7$

$0.38 < f/L < 1.2.$

4. A projection optical system having a plurality of optical elements arranged along an optical path between a first plane and a second plane for forming an image on the first plane on the second plane, wherein

at least one diffractive optical element having a diffraction pattern surface formed on one surface and a correction surface formed on an other surface is arranged along said optical path,

and said correction surface corrects a manufacturing error on said diffraction pattern surface.

5. A projection optical system according to claim 4, wherein said correction surface has a slightly aspheric surface which has been subjected to aspheric surface processing with a sag amount of 0.5 μm or less with respect to a predetermined reference plane.

6. A projection optical system according to claim 5, wherein said reference plane is a flat or spherical surface.

Sub A3

7. A projection optical system according to claim 1, wherein all the diffraction patterns of said diffractive optical elements are formed on a flat substrate.

8. A projection optical system according to claim 1, wherein diffraction patterns of said diffractive optical elements are formed in a plurality of ring areas centered on an optical axis, said each ring area being formed of a binary optical element approximated in a plurality of stages by a plurality of surfaces, and said binary optical element formed in said each ring area has a positive power, respectively.

9. A projection optical system according to claim 8, wherein at least one stage number of the binary optical elements respectively formed in said each ring area is different from the stage number of other binary optical elements.

Sub A4

10. A projection optical system according to claim 8, wherein a filter having a different transmittance according to each ring area is arranged in the vicinity of said diffractive optical element.

11. A projection optical system according to claim 1, wherein the diffraction patterns of said diffractive optical elements are formed in a plurality of ring areas centered on an optical axis, each of said respective ring areas having a sawtooth cross-section having a positive power.

12. A projection optical system according to claim 11, wherein the diffraction pattern of said diffractive optical element is formed in a first ring area and a second ring area, centered on a mutual optical axis, said first ring area being formed on the side of the optical axis from said second ring area, and having a sawtooth cross-section in which the diffraction efficiency becomes highest with regard to the 1st or -1st diffracted light, and said second ring area being formed on the side of the periphery from said first ring area, and having a sawtooth cross-section in which the diffraction efficiency becomes highest with regard to the mth or - mth diffracted light (m is an integer equal to or greater than 2).

13. A projection optical system according to claim 1, wherein said plurality of optical elements constituting said projection optical system have lenses contributing to forming an image on the first plane on the second plane, and all the lenses constituting said projection optical system are constituted of fluorite.

14. A projection optical system according to claim 1, wherein said optical system having a negative power has an aspheric surface.

15. A projection optical system wherein a plurality of optical elements are respectively arranged along an optical path between a first plane and a second plane for forming an image on the first plane on the second plane,

and at least one of said plurality of optical elements has an optical surface formed on one surface and a correction surface formed on an other surface,

and said correction surface corrects a manufacturing error on said optical surface.

16. A projection optical system according to claim 15, wherein said correction surface has a slightly aspheric surface which has been subjected to an aspheric surface processing with a sag amount of 0.5 μm or less with respect to a predetermined reference plane.

17. A projection optical system according to claim 3, wherein an optical system having a positive power is arranged in the optical path between said diffractive optical element and said second plane, and

said optical system arranged in the optical path between said first plane and said diffractive optical element has a positive power.

18. An exposure apparatus comprising:

a mask stage for setting a mask having a predetermined pattern formed thereon on a first plane;

a substrate stage which sets a photosensitive substrate on a second plane;

an illumination optical system which illuminates said mask set on said first plane; and

a projection optical system according to claim 1, which performs projection exposure of a pattern image of said mask on said photosensitive substrate.

19. A manufacturing method of micro devices including:

a first setting step for setting a mask having a predetermined pattern on a first plane;

a second setting step for setting a photosensitive substrate on a second plane;

an illumination step for illuminating said mask;

an exposure step for performing projection exposure of a pattern image of said

mask onto said photosensitive substrate, using a projection optical system according to claim 1; and

a development step for developing said photosensitive substrate to which said image has been transferred.

20. An exposure apparatus comprising:

a mask stage which sets a mask having a predetermined pattern formed thereon on a first plane;

a substrate stage which sets a photosensitive substrate on a second plane;

an illumination optical system which illuminates said mask set on said first plane; and

a projection optical system according to claim 3, which performs projection exposure of a pattern image of said mask on said photosensitive substrate.

21. A manufacturing method of micro devices including:

a first setting step for setting a mask having a predetermined pattern on a first plane;

a second setting step for setting a photosensitive substrate on a second plane;

an illumination step for illuminating said mask;

an exposure step for performing projection exposure of a pattern image of said mask onto said photosensitive substrate, using a projection optical system according to claim 3; and

a development step for developing said photosensitive substrate to which said image has been transferred.

22. An exposure apparatus comprising:

a mask stage which sets a mask having a predetermined pattern formed thereon on a first plane;

a substrate stage which sets a photosensitive substrate on a second plane;

an illumination optical system which illuminates said mask set on said first plane; and

a projection optical system according to claim 4, which performs projection exposure of a pattern image of said mask on said photosensitive substrate.

23. A manufacturing method of micro devices including:

a first setting step for setting a mask having a predetermined pattern on a first plane;

a second setting step for setting a photosensitive substrate on a second plane;

an illumination step for illuminating said mask;

an exposure step for performing projection exposure of a pattern image of said mask onto said photosensitive substrate, using a projection optical system according to claim 4; and

a development step for developing said photosensitive substrate to which said image has been transferred.

24. An exposure apparatus comprising:

a mask stage which sets a mask having a predetermined pattern formed thereon on a first plane;

a substrate stage which sets a photosensitive substrate on a second plane;

an illumination optical system which illuminates said mask set on said first plane;

and

a projection optical system according to claim 15, which performs projection exposure of a pattern image of said mask on said photosensitive substrate.

25. A manufacturing method of micro devices including:

a first setting step for setting a mask having a predetermined pattern on a first plane;

a second setting step for setting a photosensitive substrate on a second plane;

an illumination step for illuminating said mask;

an exposure step for performing projection exposure of a pattern image of said mask onto said photosensitive substrate, using a projection optical system according to claim 15; and

a development step for developing said photosensitive substrate to which said image has been transferred.

26. An optical element having an optical surface formed on one surface and a correction surface formed on an other surface, and said correction surface corrects a manufacturing error on said optical surface.

27. An optical element according to claim 26, wherein said optical surface comprises a diffraction pattern surface.

28. An optical element according to claim 26, wherein said correction surface has an aspheric surface which has been subjected to an aspheric surface processing with a sag amount of 0.5 μm or less with respect to a predetermined reference plane.

29. An optical element according to claim 27, wherein said correction surface has an aspheric surface which has been subjected to an aspheric surface processing with a sag amount of 0.5 μm or less with respect to a predetermined reference plane.